Declaring Victory on Legacy Issues

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Beryllium Legacy at Y-12

- The processing of beryllium has been an important part of the Y-12 mission since the 1950's
- Mission completion has required the execution of:
  - beryllium processing
  - Research
  - Storage activities in numerous locations throughout the plant
- Dynamic nature of Y-12's mission has resulted in
  - Frequent changes in physical location
  - Frequent changes in process requirements
- Potential for beryllium contamination existed on equipment, building surfaces, or other surfaces

Purpose and Objectives of Characterization Effort

- Purpose
  - Evaluate and identify the presence of beryllium in accordance with 10 CFR 850 and in conjunction with ongoing efforts to ensure worker protection and pubic safety
  - Document a scientifically based beryllium characterization sampling plan for evaluating buildings at the DOE Y-12 National Security Complex
- Objectives
  - Systematically characterize locations of potential beryllium contamination so that a baseline beryllium inventory could be prepared in accordance with 10 CFR 850.20
  - Provide data that can be utilized in conducting the beryllium hazard assessments in accordance with 10 CFR 850.21
  - Utilize a risk-based approach that is logical and defensible as well as flexible in application

Beryllium Characterization Plan

- Y/TS-1815 *Surface Beryllium Characterization at the U.S Department of Energy's Y-21 National Security Complex*
- Date of Issue: March 13, 2001
- Plan Prepared by:
  - L. C. Brantley, CIH, Industrial Hygiene
  - L. E. Cooke, CIH, Industrial Hygiene
  - S. M. Hollenbeck, CIH, Industrial Hygiene
  - R. S. Leete, Jr., PhD, Statistician
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  - S. D. Anderson, CIH, PrSM Corporation
- Plan Approved by: R. T. Ford, CIH, Industrial Hygiene Manager

Survey Technical Approach

- Identify Characterization Areas using Historic Data and Interviews
- Establish the Characterization Area Groups (CAGs)
- Develop the Building Specific Sampling Strategy
- Implement the Sampling Strategy
- Prepare the Characterization Report

Identification of Characterizing Areas using Historic Data and Interviews

- Compile all known data sets into a single comprehensive population of beryllium data
  - Current and historical beryllium areas list maintained by Industrial Hygiene
  - Search the Industrial Hygiene sampling database (over 500,000 beryllium samples)
- Research historic activities that generated the need for sampling
  - Preservation database
  - Past Records
  - Interviews

Establish the Characterization Area Groups (CAGs)

- Establish specific areas for statistical evaluation
- Sort Characterization areas by past sampling data
- Assignment to three categories based on past sampling results to help define CAG area size.
  - Category 1: Less than the limit of quantification at the time of the sample analysis
  - Category 2: Results range from “non-detect” to 5.0 ug/100 cm2
  - Category 3: Results are 5.0 ug/100 cm2 or above.
- Result is CAGs based on past data and process knowledge.

Grouping Multiple Characterization Areas

- Characterizing areas by past sampling results provides information on potential contamination levels that could still possibly exist and serves as a basis for a strategy to evaluate all the areas within a building.
- Similarly categorized areas, through the use of process knowledge and professional judgment, can be grouped to form logical CAGs for evaluation
- Careful consideration must be applied to this task since the results obtained may apply to all areas included in the group regardless of the actually location of samples collected and analyzed

Grouping Multiple Characterization Areas (cont)

- Square footage of the group
  - Groups composed of Category 1 areas comprise more square footage as the expectation for positive sample data is low. Positive results are a higher probability for Category 2 and 3 areas, which limited the size of these groups.
- Building Layout
  - Similar groups are logically assembled according to geographical proximity depending upon building size, number of characterization areas in a given category and area location
- End Result
  - A list of characterization areas grouped together by category, which serve as a foundation upon which a building-specific sampling and analysis plan can be developed

Develop the Building Specific Sampling Strategy

- Stratify each CAG into three similar surface types
  - Floors
  - Equipment surfaces such as desks, shelves, machinery and process equipment that would be directly contaminated from beryllium operations
  - Horizontal surfaces such as window ledges, structural steel, conduits, light fixtures, and ventilation equipment that would be indirectly contaminated by beryllium operations
  - Additional similar surface types may be evaluated separately if needed

Develop the Building Specific Sampling Strategy (cont)

- Sample Collection
  - Evaluate each strata within a CAG
  - Use a minimum of 30 random samples
  - This approach, and the computation of the average plus three standard deviations was chosen so the results could be evaluated, regardless of the underlying distribution of the population being sampled, to estimate the approximate 99th percentile and use it as a basis for making decisions
- The total number of samples for a given building or building set equals the number of CAGs (regardless of size) x 90 samples /characterization group, not including field blanks

Enhancement the Sampling Strategy

- Professional Judgment
  - With random sampling, it could occur that some characterization areas included within a larger group being sampled could be missed in the random sampling process. If this could cause management/worker concerns as to the sample fairly representing the population being sampled the taking of additional random samples in these overlooked areas is acceptable
- Additional or Corrective Actions
  - An advantage is that the approach allows for additional or corrective actions to be isolated to the similar surface types in the same CAG
- Elective Sampling
  - Elective or bias sampling may be conducted in addition to the random sampling to determine if contamination is present. However no statistical confidence is implied

Statistical Analysis

- Don’t shoot me, I am only the messenger!
- A statistical approach with an appropriate sample size that would with confidence identify areas without sample results greater than 0.2 ug/100 cm2 and also indicate areas were 10% of the samples had values higher than 0.2 ug/100 cm2. The method would need the ability to flag the “bad” areas more than 99% of the time
- Statistics evaluated
  - Largest value in the sample
  - Value computed by adding three times the standard deviation of the results to the average
  - Value computed by adding three times the standard deviation of the results to the average, where the computed standard deviation was corrected for small sample bias
  - The value computed by adding “k”times the standard deviation of the results to the average, there “k” is a tolerance interval factor published in statistical tables

Statistical Analysis (cont)

- Simulation studies on repeat samples showed that a sample size of 30 and the use of he the value computed by adding three times the standard deviation of the result of the average provided a high reliability and ease of computation
- By taking a sample size of 30 and flagging the area if the average plus three standard deviations exceeds 0.2 ug/100 cm2, the “good” area is accepted and the “bad” area is flagged more than 99% of the time
- For a normal distribution, given the average and standard deviation, then 99.6% of the population values would lie below the value computed by taking the average plus three standard deviation.
- However, beryllium sampling results do not follow a theoretical parametric distribution

Statistical Analysis (cont)

- Distributions of contamination data are almost always skewed to the right, or left censored. Giving more high readings than would be expected from a bell-curve.
- An internationally know statistician, Don Wheeler, and others have shown that regardless of the underlying distribution of results, the value established by the Average plus three standard deviations almost always bound about 99% of the population
- With this approach one can be 95% confident that 90% of the population will fall below the largest value in a sample of 30
- The tail of the distribution will not be mis-represented using a sample size as small as 30

Implementation

- Operational Rule
  - The surface level of 0.2 ug/100 cm^2 beryllium is considered to be exceeded for a surface being evaluated when:
    - A single sample result representing the surface exceeds this level or
    - The average plus three standard deviations of at least 30 random samples that represent the similar type exceed this level
  - Areas represented by smears that have a beryllium surface level that does not meeting the Operational Rule can be excluded from any further concerns or actions. Areas that have a beryllium surface level that meets the Operational Rule
    - Line management will be notified in writing and provided recommendations for continuing operations

Implementation (cont)

- Surface type within strata not at the randomly generated location
  - Use a substitute randomly generated location to sample that surface or
  - Skip the location missing a surface an sample all surfaces at a substitute randomly generated location
  - A safe sampling location within ten feet of the randomly generated point may be used.
  - Use an alternate random sampling location noted on the drawing if each of the three homogeneous surfaces is not present at a location
- Sampling above 8’ will not be performed due to safety and logistic concerns. Areas will be characterized as needed as part of individual projects or work packages

Air Sampling

- Representative personal air sampling will be conducted on field team personnel during surface sampling activities. A minimum of one personal breathing zone sample per day will be obtained during the surface sampling activities

Characterization Report

- Provide line and program management with prompt and concise report of the evaluation performed.

Characterization Overview

- Number of candidate buildings
- Number requiring characterization
- Number all non-detects
- Number detectable but less than 0.2 ug/100 cm^2
- Number equal to or greater than 0.2 ug/100 cm^2
- Number of samples taken
- Number of current Beryllium Operational Areas and Beryllium Storage Areas
- Response to Las Vegas Report